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Analysis of a Hybrid Broadband Reverberation Chamber Antenna

I. D. Flintoft, G. Esposito, A. C. Marvin, L. Dawson,
M. P. Robinson & J. F. Dawson

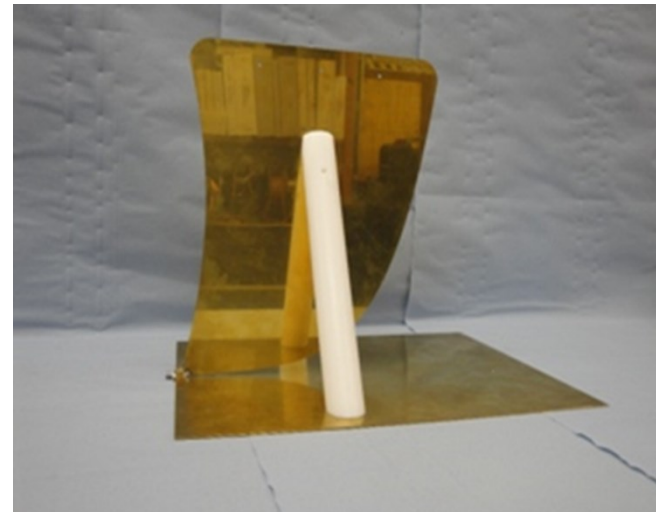
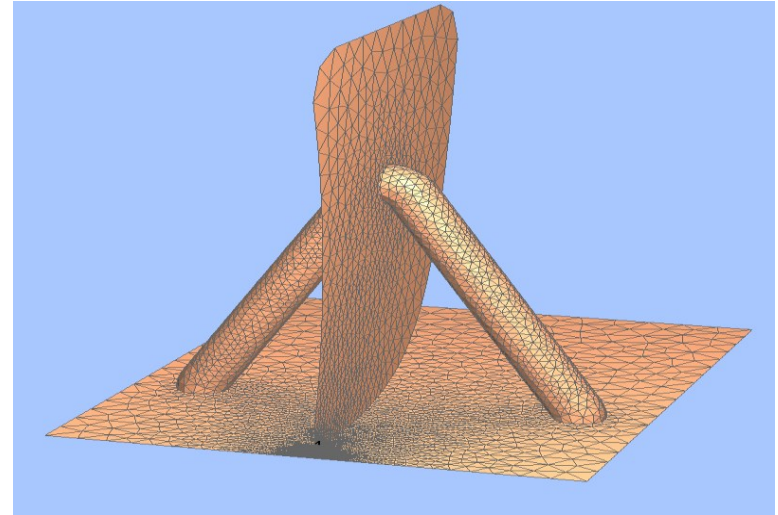
Department of Electronics, University of York, UK



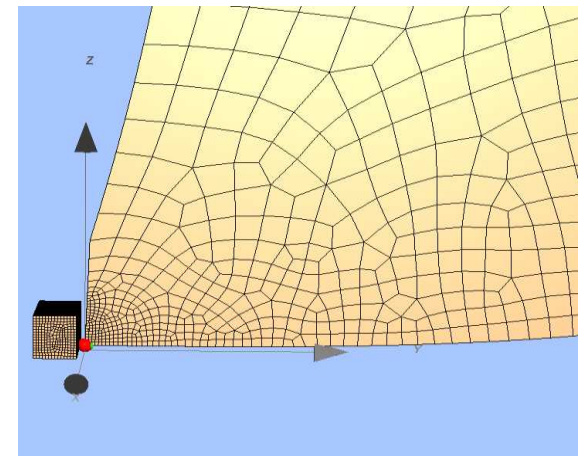
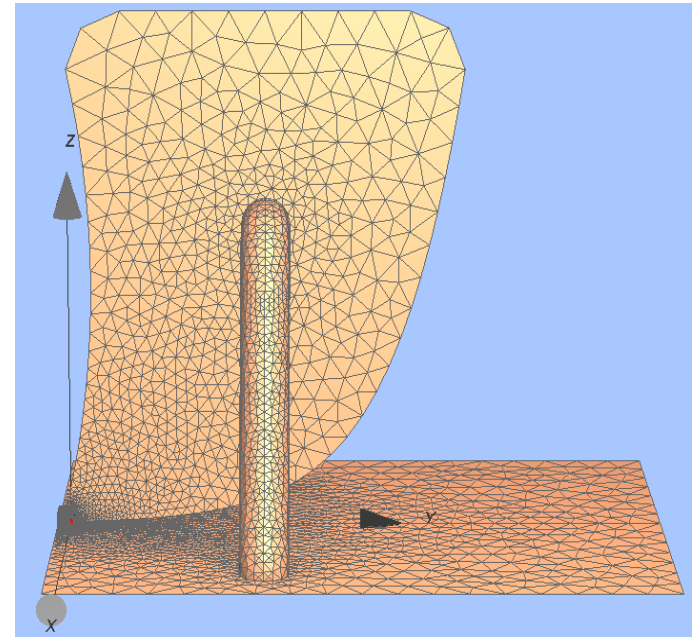
- Our aim was to produce an antenna for use in a reverberation chamber over a wide frequency range.
- Specifically the antenna should be usable in our chamber (4.8m x 3.3m x 2.2m) over the frequency range 200MHz to 20GHz.
- As with any linear structure its frequency range can be adjusted by dimensional scaling

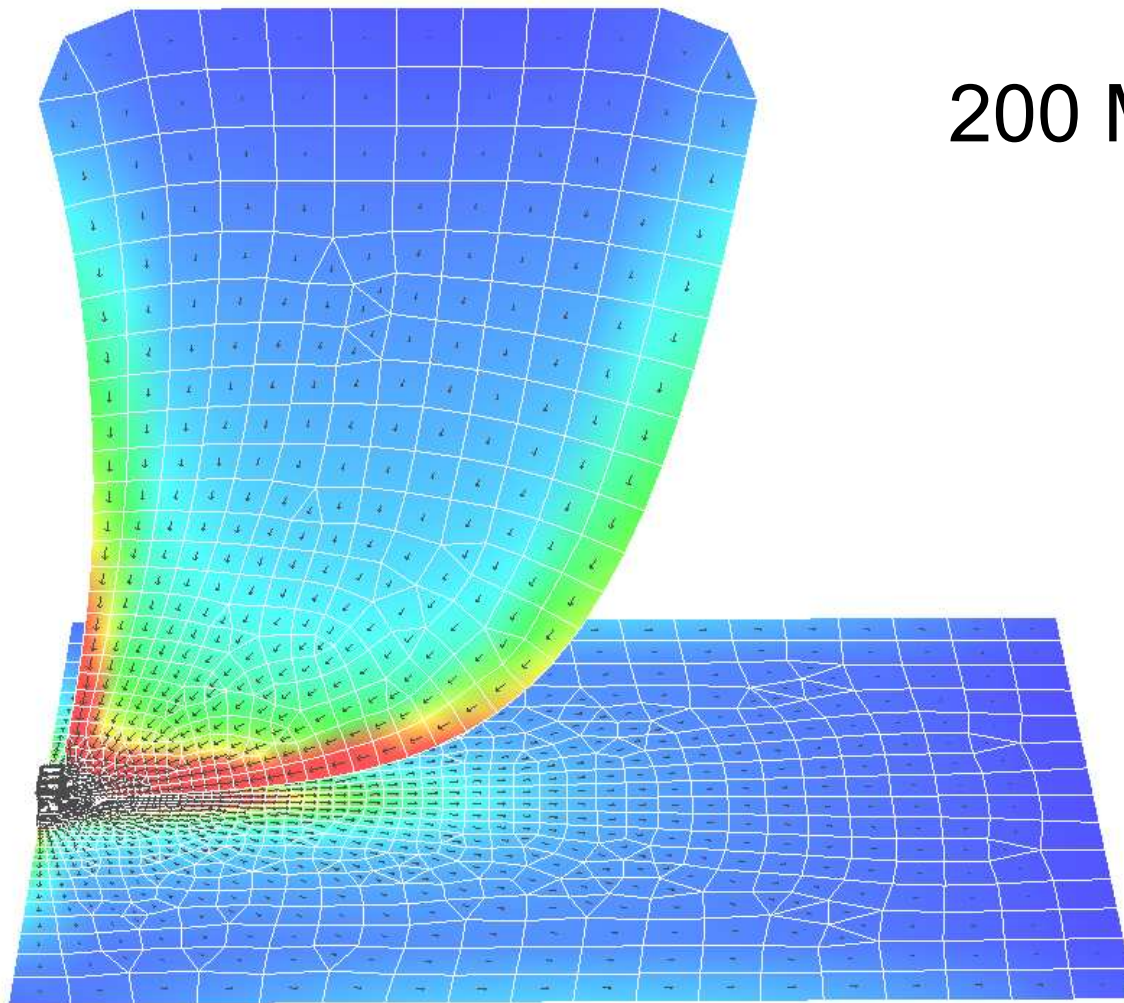
- Frequency range defined by input reflection coefficient:
 - $|S_{11}| < 0.316$ (-10dB) 200MHz – 20GHz
- Radiation pattern:
 - Not specified (isotropic in RC)
- Efficiency:
 - Maximised
- Size:
 - Minimised

- A hybrid monopole-exponential taper (Vivaldi) structure.
- Height 305mm.
- Ground plane width 300mm.
- Ground plane length 375mm.

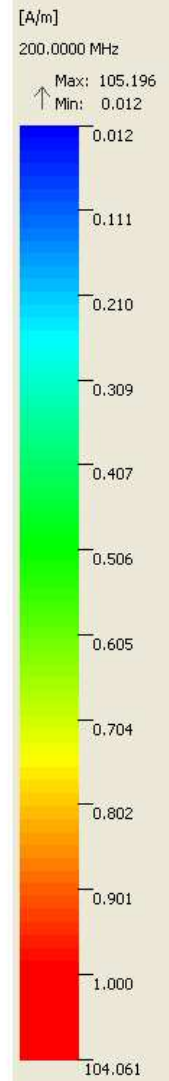


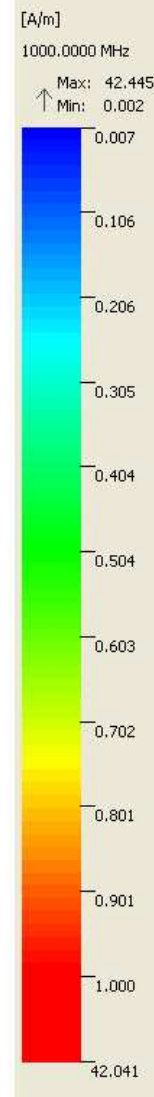
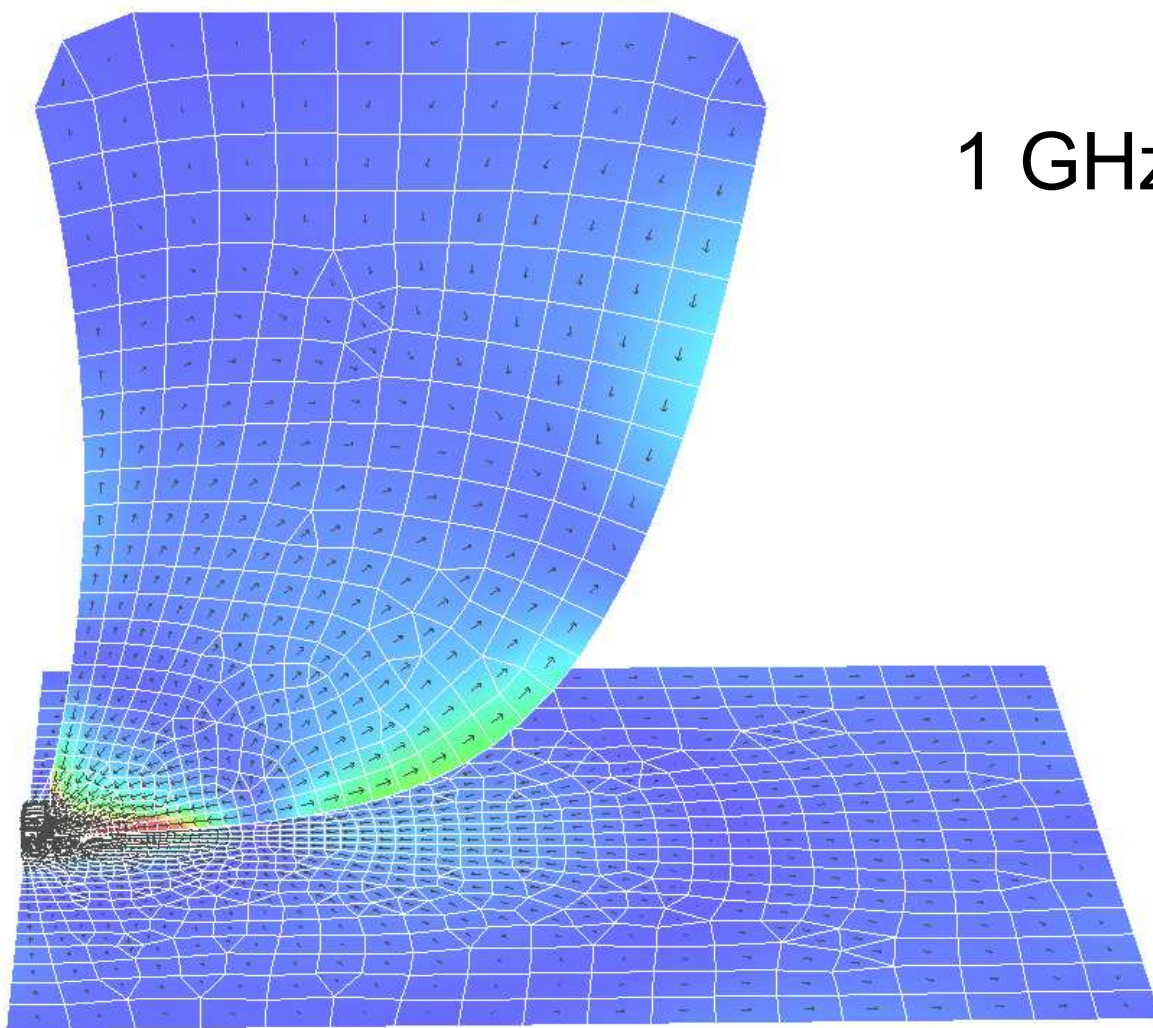
- Low frequency monopole resonant at ~ 250 MHz.
 - Determined by the effective minimum length of the monopole defined by the curved edge above the feed point.
- Simple exponential taper from 400 MHz upwards
- The key is that the taper takes over before the $\lambda/2$ anti-resonance of the monopole at ~ 500 MHz



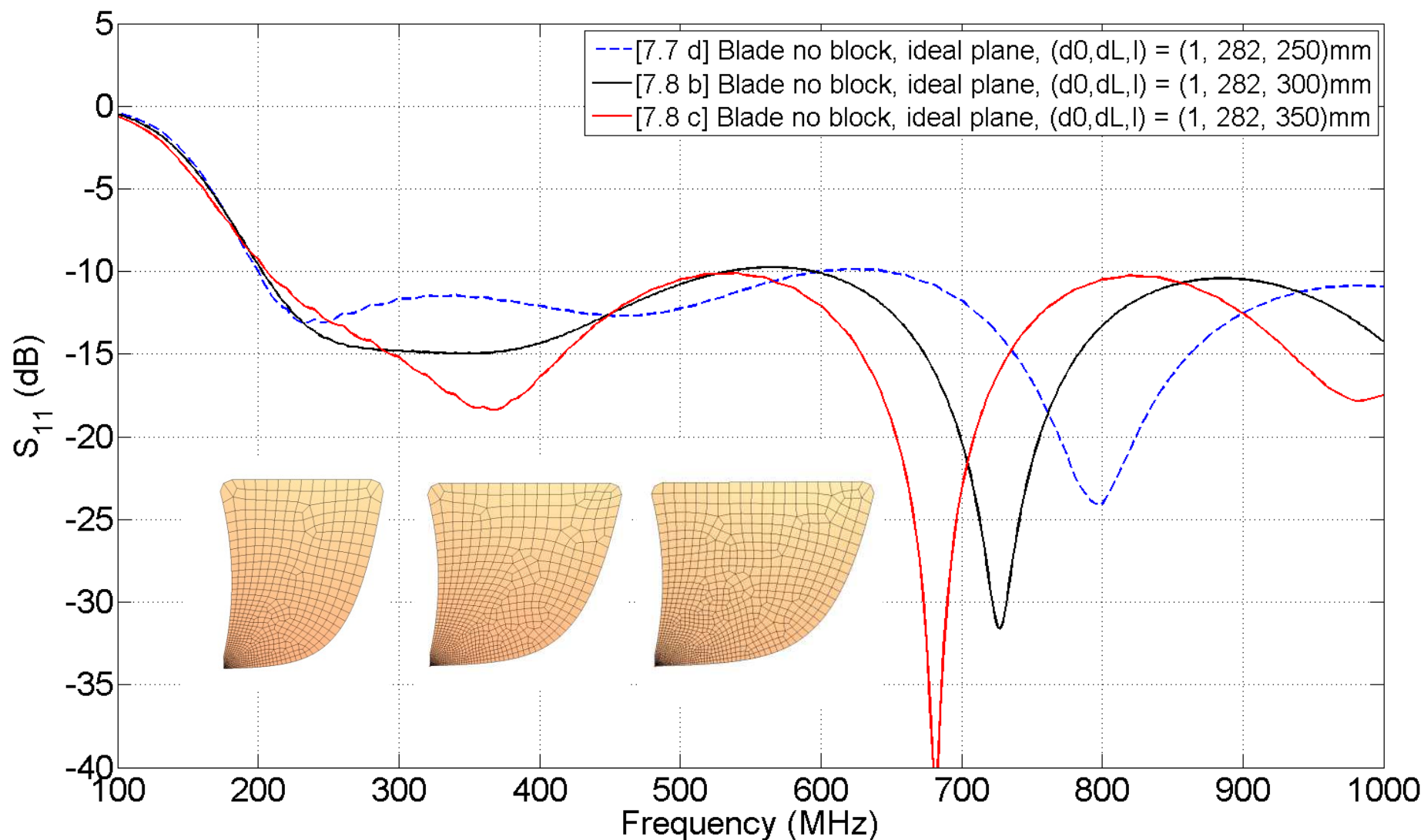


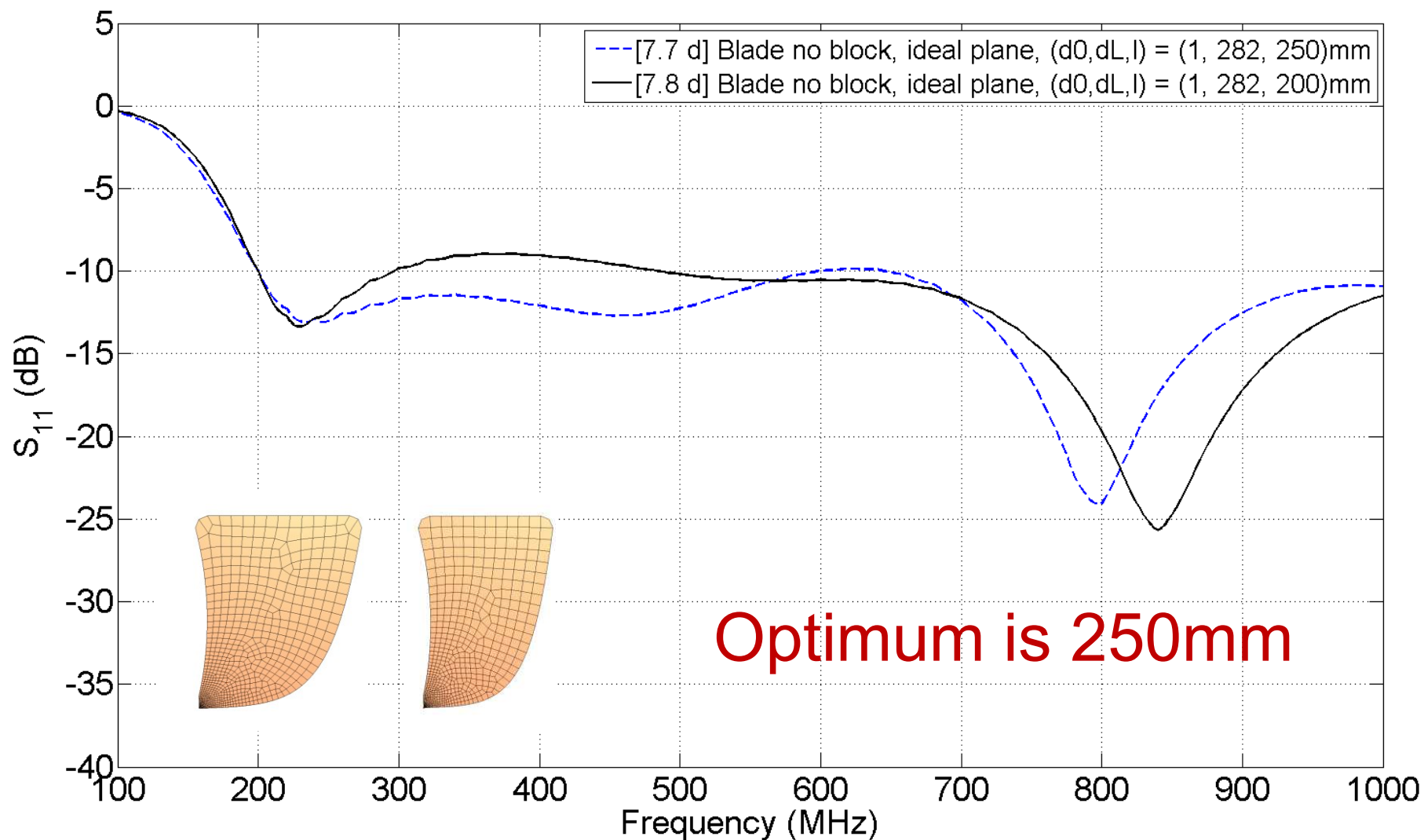
200 MHz

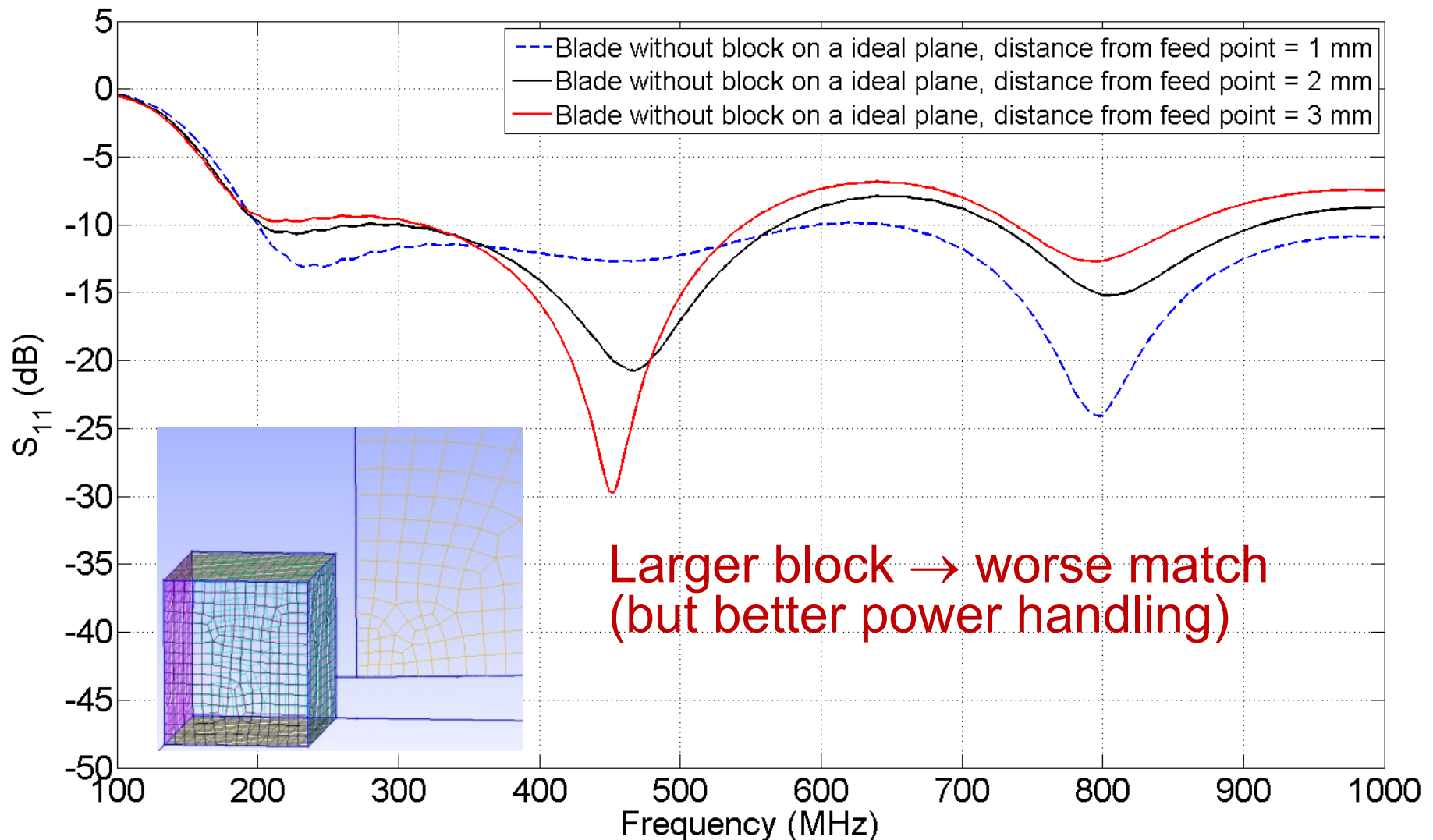


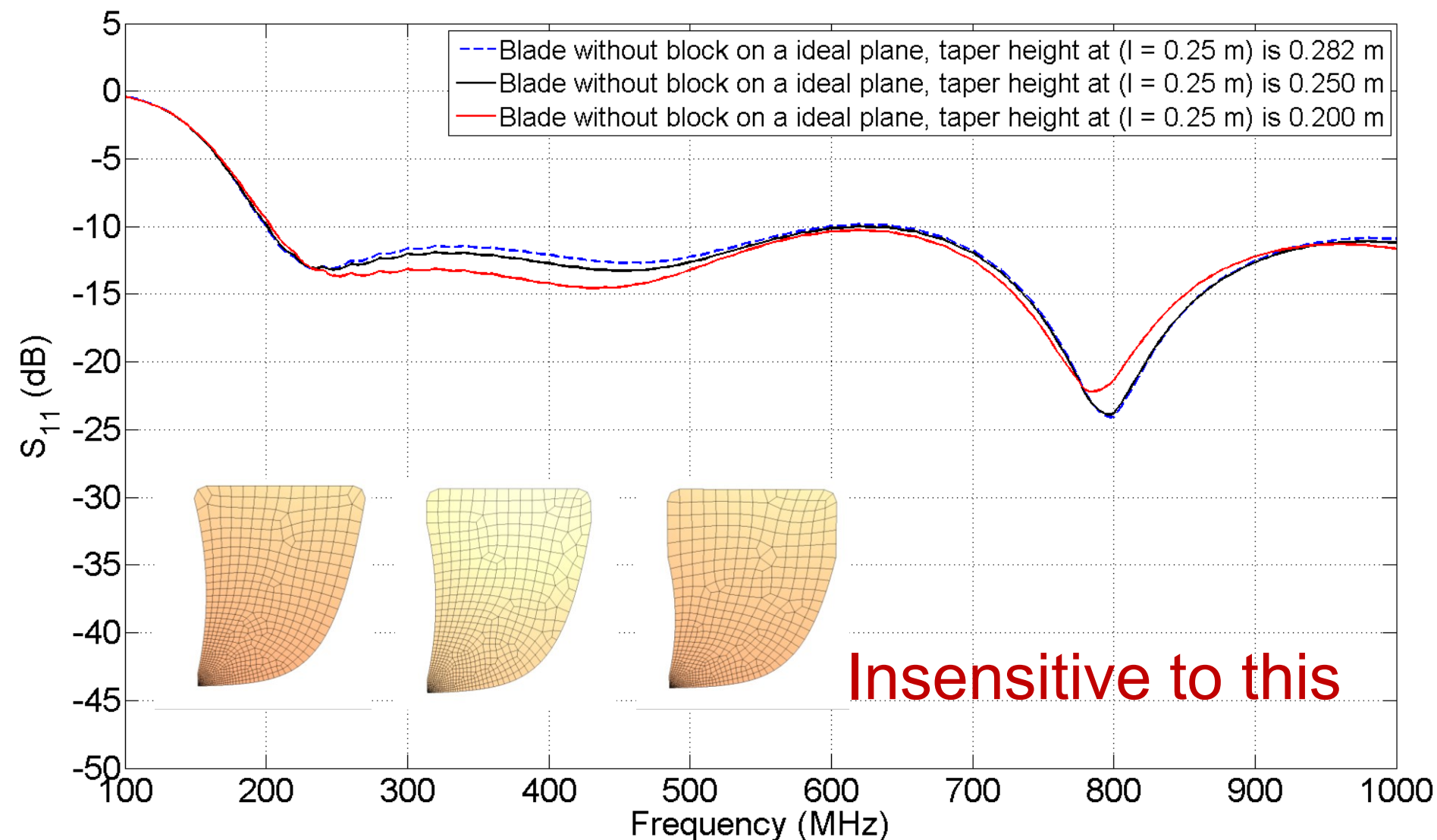


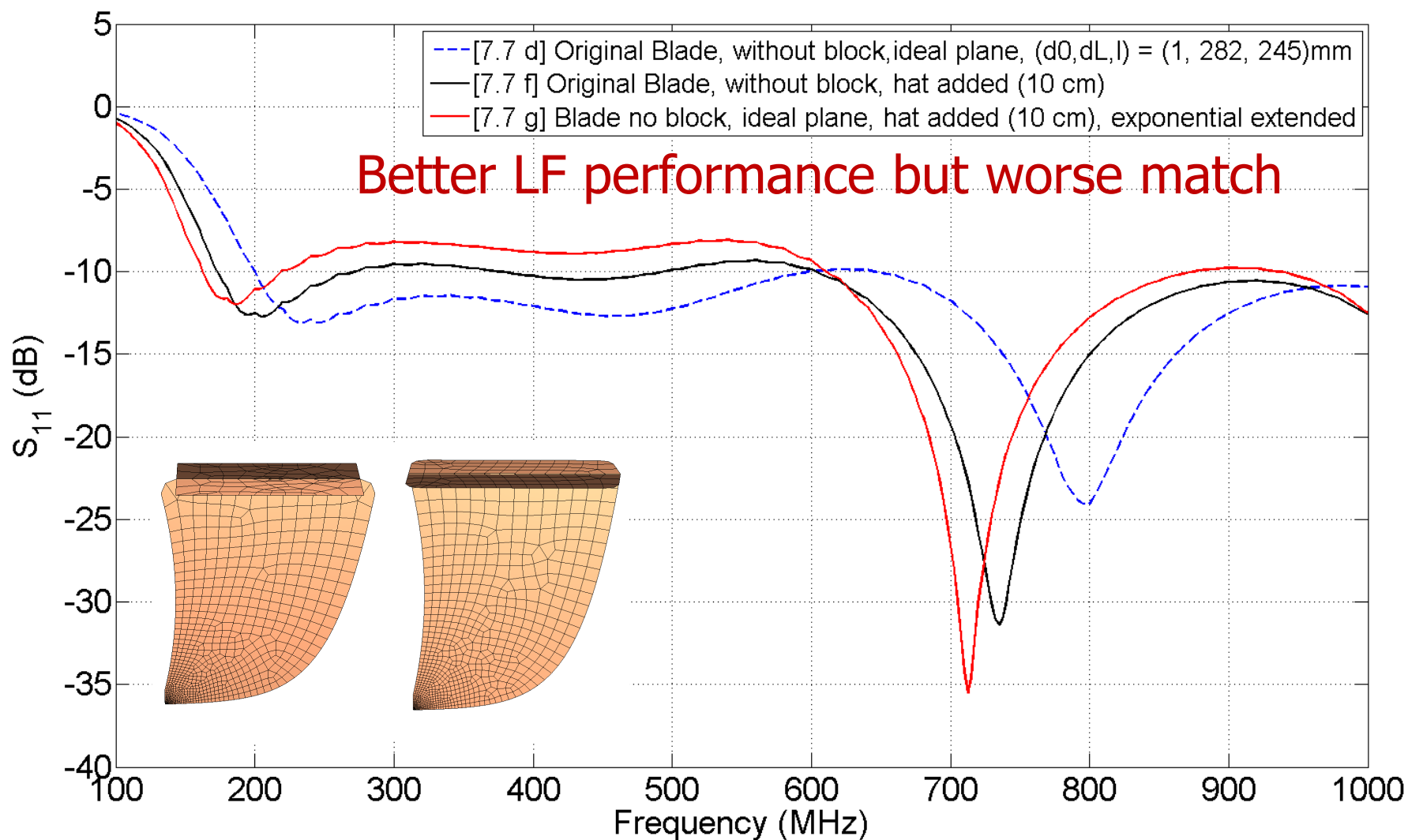
- Modelled with CONCEPT II and Gmsh
- Target: $S_{11} < -10\text{dB}$ from 200 – 1000 MHz
- Radiation pattern less important for use in reverberation chamber
- Vary parameters including length and shape of exponential taper, and size of feed block
- Mesh size ~ 1 cm at edges away from feed and $\sim 0.5\text{mm}$ near feed

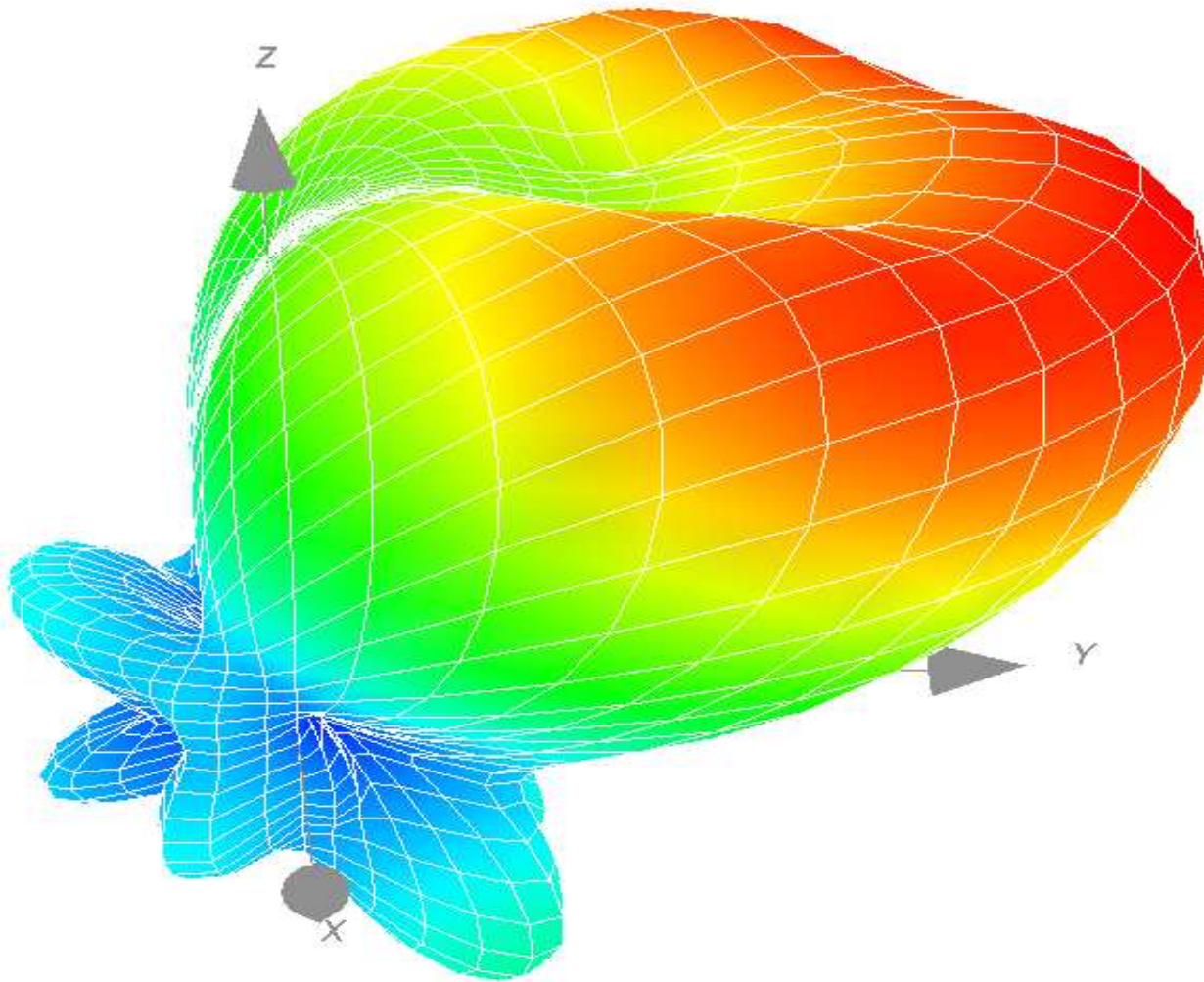




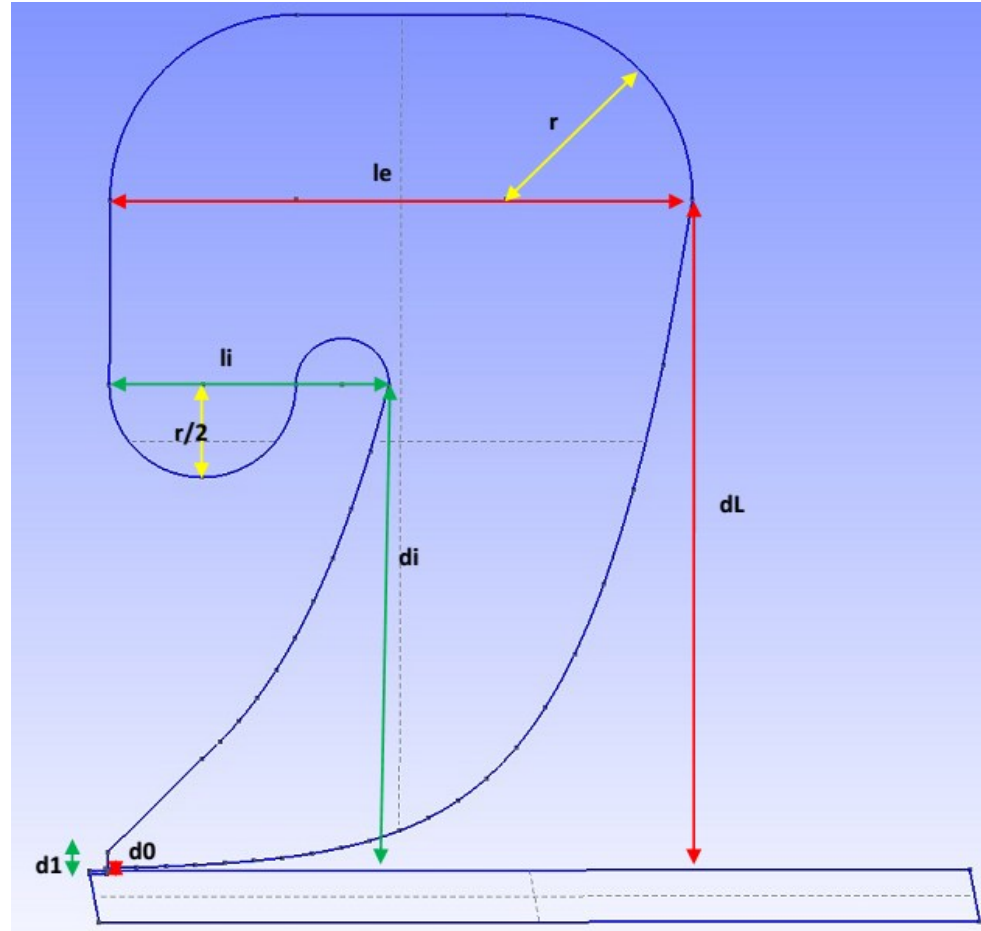




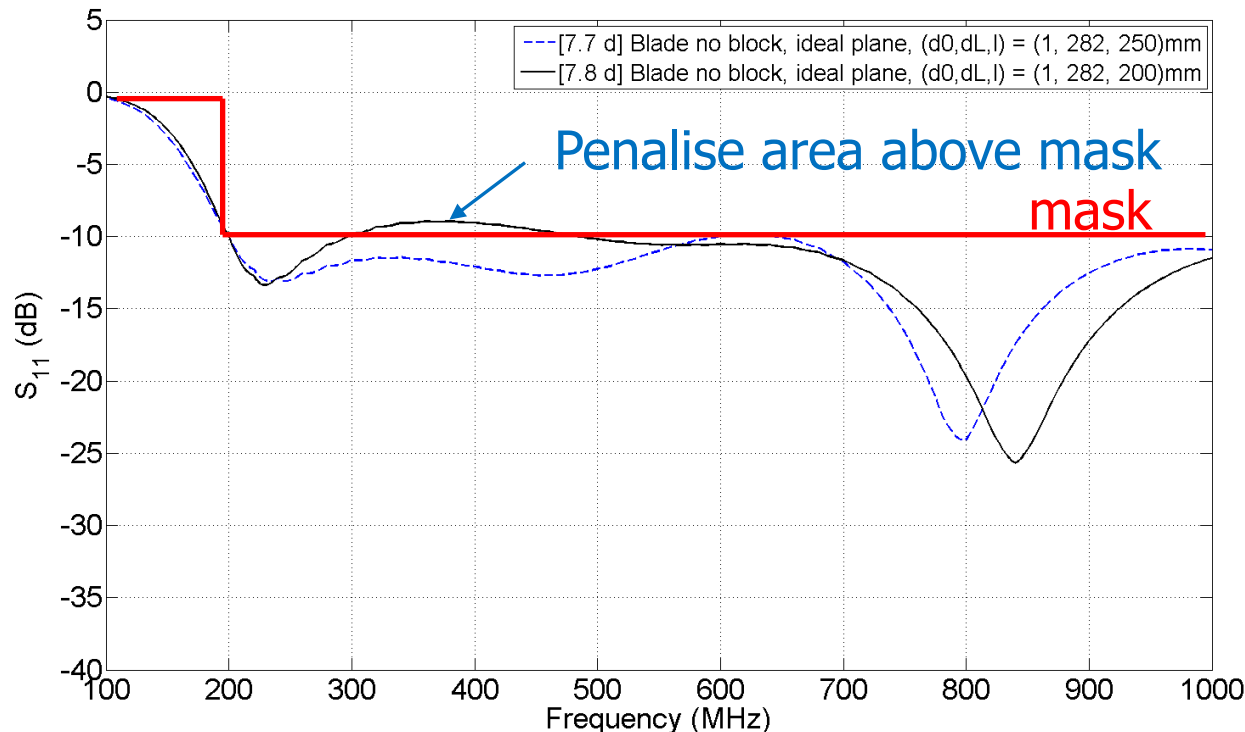




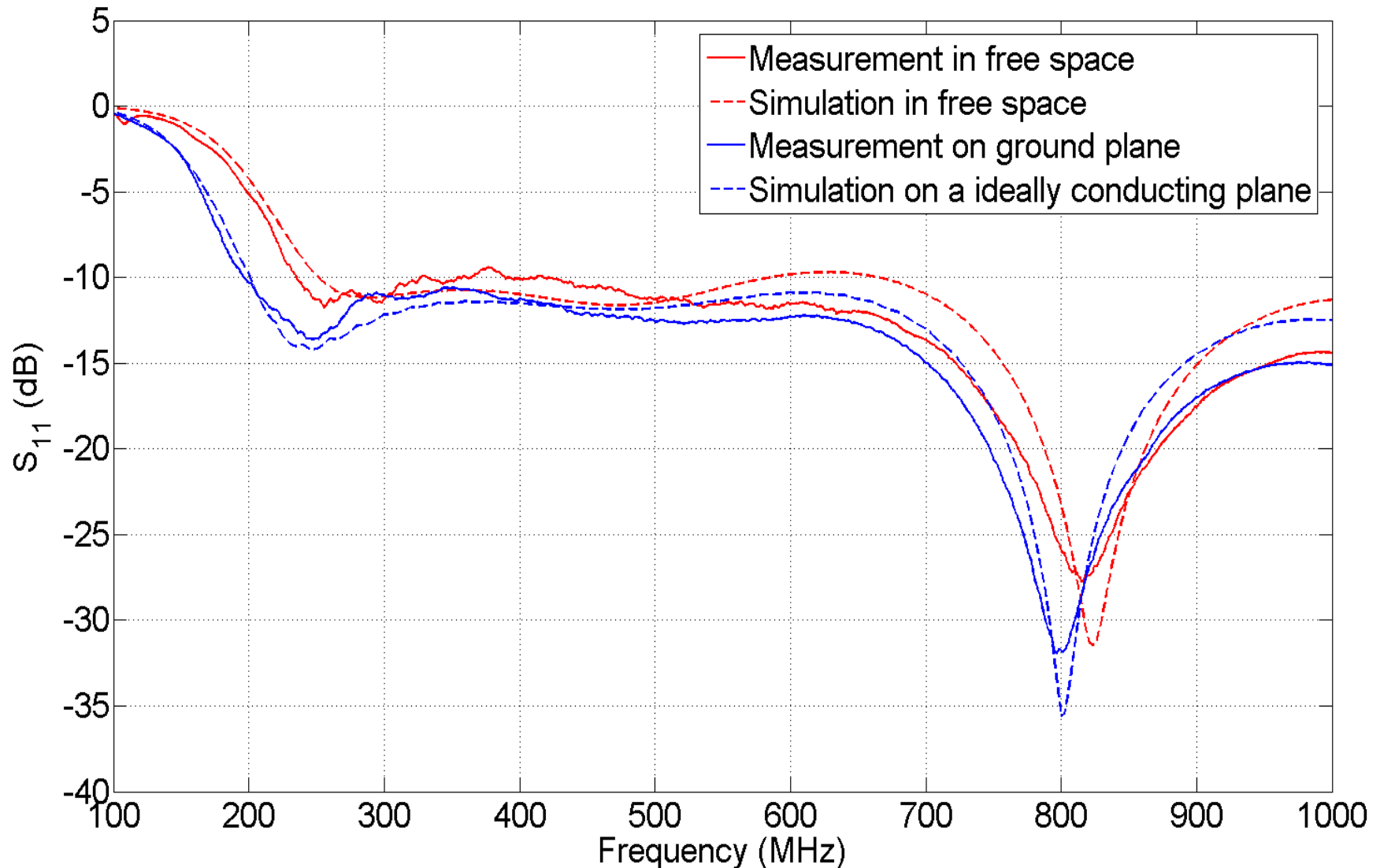
- Automatic optimisation
- Octave/MATLAB program
- Parametric CAD – Gmsh
- MATLAB GA toolbox or in-house Octave GA
- MATLAB/Octave functions to write CONCEPT input files

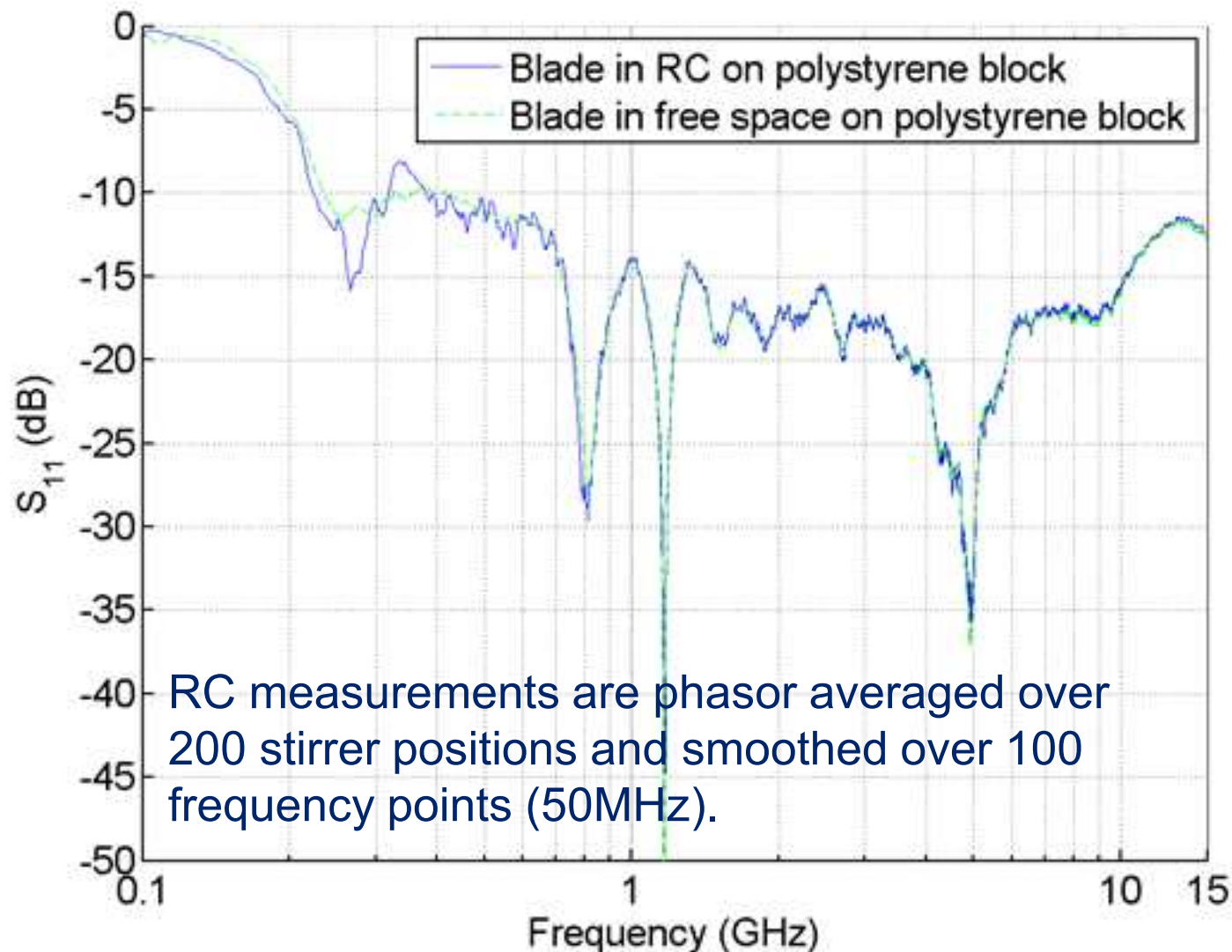


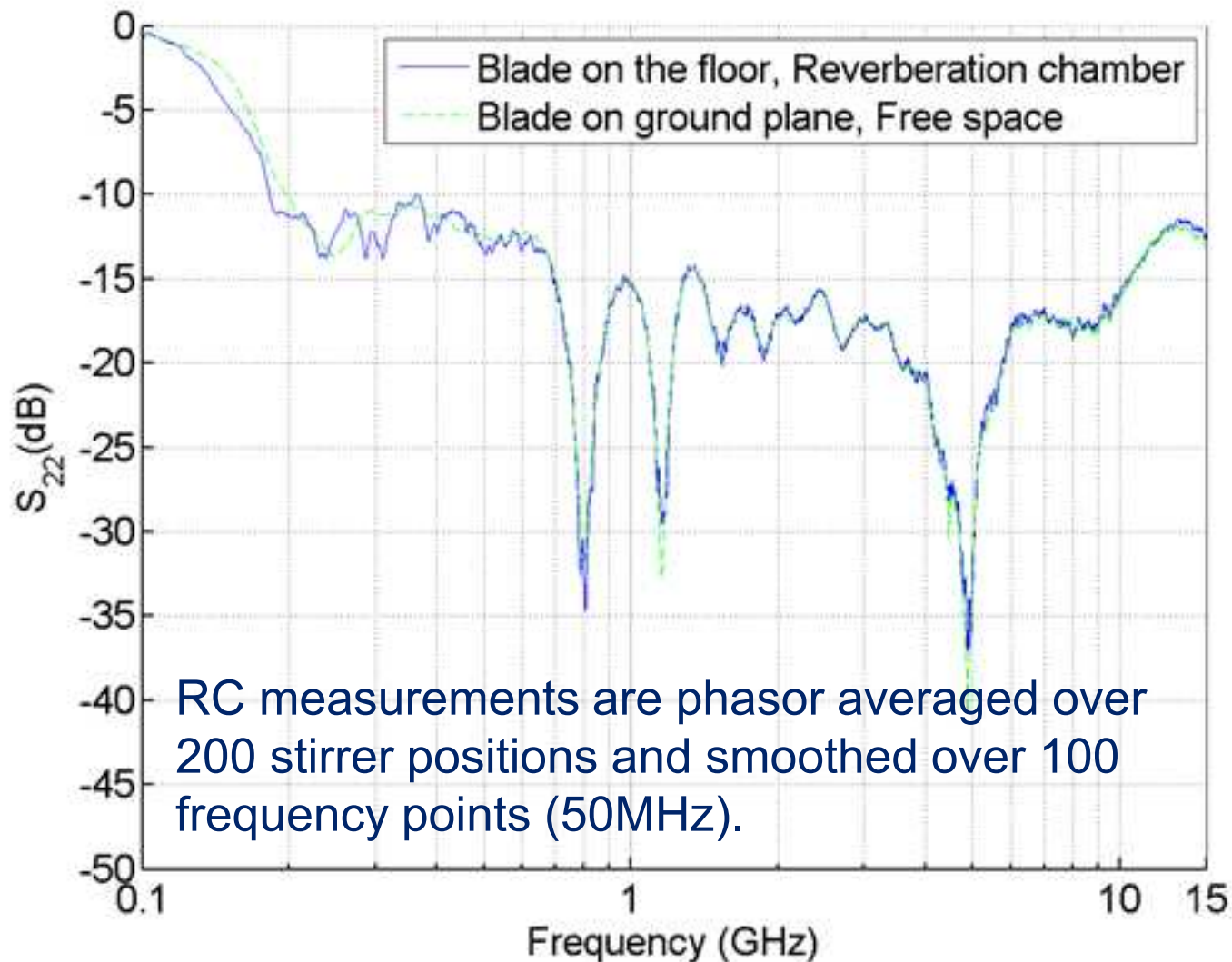
- Decode genotype -> parameters
- Create Gmsh (.geo) file with required parameters
- Create mesh using Gmsh
- Create CONCEPT input files from templates
- Run CONCEPT
- Post- process to get input impedance
- Evaluate cost function as area between $|S_{11}|$ and upper mask



- Optimise cross-over region (monopole-> taper)
- Cost function is area between S_{11} amplitude mask and simulated $|S_{11}|$.







- Successful transition between antenna modes
- Initial design was close to optimal!
- Trade-offs:
 - Feed point: S_{11} against power handling
 - Top loading: S_{11} against LF performance
- Final antennas have acceptable performance from 200 MHz to 25 GHz (maybe higher)